The Paradoxical Impact of Insurance Status on Inter-facility Transfer Times and Outcomes in Patients with ST-Elevation Myocardial Infarction

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Short Title: Impact of insurance status on ST-elevation myocardial infarction transfers
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Introduction:

Cardiovascular disease in the United States is a significant cause of mortality. In 2015, myocardial infarctions (MI) occurred about every 40 seconds within the United States with an incidence rate of approximately 790,000 Americans. [1] ST-elevation myocardial infarction (STEMI) comprises 25-40% of all MI, and they are associated with 5-6 % in-hospital and 7-18% one-year mortality. [2] Prior studies demonstrated that morbidity and mortality increases proportionate to the total ischemic time, which is the time of symptom-onset to time of treatment. [3] Thus, the American College of Cardiology (ACC) and American Heart Association (AHA) published 2013 guidelines to reduce total ischemic times. [4]

Disparities in timely intervention for STEMI patients occur due to many factors. Patients who present at a non-percutaneous coronary intervention (PCI) capable hospital are especially at risk for increased for delays. Miedema et al reported that roughly one third of patients in their study transferred for primary PCI in Minnesota were treated in >120 minutes, which is outside the ACC/AHA recommended time. [5] Their study also elucidated that most delays were at the referral hospital, followed by delays at the PCI center, while transportation contributed the least amount.

Although it is known that uninsured patients have been shown to have worse clinical outcomes in disease processes requiring acute care [6], studies regarding insurance status and inter-facility transfer times for STEMI patients are limited. Herrin et al discovered a small but statistically significant delay in door-to-balloon time for Medicaid and uninsured STEMI patients versus the privately insured, [7] while Ward et al from found that uninsured STEMI patients are more likely to be transferred but it is unclear if this is based on non-availability of PCI or purely due to lack of insurance. [8] In our study, we sought to determine the impact of insurance status on inter-facility transfer times and length of stay for STEMI patients.

Methods:

A retrospective analysis was conducted on STEMI patients transferred from outside hospitals to our PCI-capable institution between September 2008 and January 2013. Patients were categorized into two groups based on their insurance status: uninsured patients, who do not possess any form of insurance and insured patients, who have insurance plans sponsored by a private or public provider.

A univariate analysis, consisting of independent sample t-tests and Chi square, was used to compare baseline characteristics and outcomes of insured and uninsured patients. Not all baseline characteristics had a complete data set to account for all patient descriptors. Patients without complete data were excluded from analysis.

Transfer distance was measured maps from the transferring facility to the PCI facility. Ground distance was determined by selecting the route with the shortest duration Air distance was calculated by measuring the linear distance between the transferring facility and the PCI facility.

The door to balloon (DTB) time was divided into two intervals: 1) door in at presenting facility to door in at PCI-capable hospital (DIDI) and 2) arrival at PCI-capable hospital to balloon time. DIDI time was calculated by subtracting arrival time at the outlying facility from arrival time at the PCI facility. Arrival to balloon time was calculated by subtracting arrival time at the PCI facility from the time at which the lesion was treated during cardiac catheterization. DTB time is the sum of these two intervals. Data were not available for the interval between first medical contact and departure time from the transferring facility. A Mann Whitney U test was used to compare median times for each time interval listed above based on type of insurance.

Analysis was performed using IBM, SPSS version 25.

Results:

During September 2008 and January 2013, there were a total of 1144 STEMI patients at our institution. Out of the 1144 patients, 348 patients were transferred from outlying facilities for the treatment of a STEMI. Of these, 235 patients were transferred with complete transfer time data and were included in the analysis for our study. The mean age for the entire study population was 61.52 years, 70.2% were male, 57.9% were white, and 23.4% had history of previous myocardial infarction. The majority of the patients were insured (185, 78.7%) and the remaining 50 (21.3%) patients were uninsured. Baseline characteristics (Table 1) were similar between the two groups except insured patients had a higher incidence of hypertension and less tobacco abuse when compared to the uninsured group. ($p<0.05$). There was no significant difference in the mode of transportation or distance travelled between the two groups (Table 1).

In our population, we found that insured patients had a significantly longer median door to balloon time, 155 minutes compared to 124 minutes ($p=0.03$). In addition, the insured patients had a significantly long median DIDI time, 124 minutes compared to 78 minutes for uninsured patients ($p=0.03$). The median arrival at PCI capable facility to balloon time of was similar, 54 minutes versus 53 minutes between insured and uninsured patients, respectively ($p=0.422$).

Insured patients had a longer length of stay in the hospital compared to uninsured patients (5.4 vs 3.0 days, $p<0.05$). There was no significant difference between the two groups in ejection fraction, peak troponin, rates of shock, intubation, intra-aortic balloon pump placement or in hospital mortality.

Discussion:

The review of literature shows that uninsured STEMI patients present conflicting data. [7-11] For the most part, uninsured patients are transferred out and discharged more readily from the receiving facilities, possibly due to the potential financial impact. In patients where time critical diagnosis (TCD) is encountered, guidelines dictate transfer to a facility where optimal management is available. [3] However, when there is a non-critical diagnosis, there is a tendency to stabilize the uninsured patient and discharge them from the presenting facility. Hence, a paradox in decision making exists in patients depending on whether the presenting condition is a TCD.

In our study we found that insured patients who are transferred to a PCI capable facility for a STEMI experience longer door to balloon times when compared to the uninsured. More specifically, DIDI times were significantly different while the median door to balloon time at the PCI capable facility is similar between the insured and uninsured (Table 2). In addition, we found no difference in the transfer distance between these two groups. The DIDI time disparity is concerning as it may point towards the potential impact of insurance status on STEMI patients who are transferred. The similar door to balloon times at the receiving facility validates the preparedness of the receiving facility to deal with the transferred patient.

We propose that the difference in DIDI times could be a reflection of an administrative component. The requirement of trying to identify an "in-network" receiving facility for insured patients potentially creates logistical barriers to transfer. Thus, uninsured patients are more easily transferred, which in turn leads to shorter DIDI times. The time spent in identifying in network facilities for transfer may be detrimental to the outcome of these critical patients and may merit a review of the transfer process.

The clinical significance of delayed DIDI times is demonstrated in our data. Insured patients were found to have a longer length of stay then the uninsured (5.4 days vs 3.0 days, $p<0.05$) (Table 3). Higher elevation in troponin levels as well as rates of shock and intubation in the insured patients were seen, but not found to be statistically significant. This could be a result of the delayed DIDI time seen in insured patients and may be a harbinger of potentially greater morbidity and mortality associated with this group. Fortunately, there was no statistically significant difference in hospital mortality between the two groups in our study. However, randomized controlled trials in STEMI management have consistently shown that 30-day mortality rates increase progressively with longer door to balloon times.

Conclusion:

STEMI patients with insurance have a longer door in to door in time when compared to their uninsured counterparts. Further studies are needed to review the transfer procedures between insured and uninsured patients to potentially identify and reduce worsening clinical outcomes.

Limitations:

The results of our study are subject to several limitations. This study was a secondary analysis on a dataset that was established for the primary purpose of quality improvement in managing the TCD of STEMI. Therefore, while the analysis studies timeliness of transfers and the variables that impact duration of time intervals at referring EDs, the data does not allow for assessing the timeliness of all the processes in these EDs.

In addition, standardization of timing the events has to be established and the index EKG be identified in standard way as some rural ambulance systems in our catchment areas are still not equipped to transmit STEMI EKGs from the field and such a disparity may play a role in the transfer times. As the original purpose of the data collection was quality improvement and operational stream-lining, future studies will need to be conducted in a prospective manner with uniform time measures in place to confirm the true representativeness of our findings.

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Table 1: Baseline Characteristics

Variable (%)	Insured (n=185)	Uninsured (n= 50)	*p*-value
Age (SEM)	62.1 (0.9)	59.4 (1.6)	0.15
Male Sex	132 (71.4)	33 (66.0)	0.47
Caucasian	109 (58.9)	29 (58.0)	0.54
Body mass index	30.3 (0.5)	29.9 (0.9)	0.68
Hypertension	133 (71.9)	25 (50.0)	<0.05
Diabetes Mellitus	61 (33.0)	14 (28.0)	0.51
Hyperlipidemia	60 (32.4)	10 (20.0)	0.09
Heart Failure	16 (8.6)	1 (2.0)	0.11
Chronic Kidney disease	7 (3.8)	1 (2.0)	0.46
End Stage Renal Disease	3 (1.6)	0 (0.0)	0.49
Previous Myocardial Infarction	47 (25.5)	7 (14.0)	0.09
Tobacco use	99 (54.1)	39 (78.0)	<0.05
Alcohol use	45 (24.6)	16 (32.0)	0.29
Cocaine use	5 (2.7)	1 (2.0)	0.78
Family History of CAD	87 (48.9)	28 (56.0)	0.38
Mode of Transportation			0.25
Ground	100 (55.2)	34 (68.0)	
Air	80 (44.2)	16 (32.0)	
Distance travelled in miles	55.5 (15.7)	65.4 (7.7)	0.68

Table 2: Door to Treatment Times

Median times in minutes (IQR)	Insured (n=185)	Uninsured (n= 50)	*p*-value
Door to balloon	155 (112:272)	124 (95:217)	0.03
Door in to door in	124 (65:215)	78 (40:180)	0.03
Arrival at PCI facility to balloon	54 (25:102)	52 (27:74)	0.42

Table 3: Outcomes

Outcome (%)	Insured (n=185)	Uninsured (n= 50)	*p*-value
Mortality	9 (4.9)	2 (4.0)	0.80
Length of stay in days	5.4 (0.3)	3.0 (0.6	<0.05
Ejection fraction (SEM)	42.7 (1.3)	44.0 (2.1)	0.49
Intra-aortic balloon pump	25 (13.9)	6 (12.5)	0.80
Peak Troponin	19.9 (2.4)	16.0 (4.3)	0.53
Shock	23 (12.7)	3 (6.1)	0.31
Intubation	15 (8.3)	1 (2.1)	0.20